Remarks

1.   This amendment responds to the Office Action dated November 6, 2002. A request for a two

(2) month extension of time to respond to the outstanding Office Action is enclosed. The fee is

$205.00 for the extension. This amendment deletes six (6) claims and adds nine (9) new claims and

converts a previously dependent claim into an independent claim. The additional fee for these claims

(Small Entity) is $153.00. Please debit Deposit Account No. 03-1231 for the $358.00 fee for the two

month extension of time and the additional claim fee. If the fee is inadequate, please debit or credit

Deposit Account No. 03-1231 for any overpayments/underpayments.

2.   Applicant encloses the signed Patent Declaration as requested by the Examiner.

3.   Applicant submits an Abstract herewith and points out that the PCT application contained

an Abstract.

4.   The substitute specification submitted herewith combines the amendments made at the PCT

International Stage and the published PCT application. No new matter is introduced in the substitute

specification. Applicant has deleted reference to the claims as shown in the amendments to the

patent specification set forth above. The substitute specification incorporates these changes. No new

matter is introduced by these changes to the specification and the claims.

5.   Drawings

        Figs. 1a, 1b, 2a and 2b relate to known prior knowledge as to the nature of and functional

operation of circumferential magnetisation as described in the referenced Garshelis patents. The

explanation given is also applicable to the use of circumferential magnetisation as disclosed in

WO99/56099, mentioned on page 3 of WO00/57150.   However, Fig. 1C is drawn from

WO99/56099 at Fig. 13a which has a U.S. counterpart in U.S. Serial 09/673930.   U.S. Serial

09/673930 and the captioned patent application are commonly owned. Hence, FIG. 1C herein is not prior art and is not labeled as such. A corrected sheet for the formal drawings is enclosed.

7.   Claim Rejections: 35 USC 112

a)   Applicant does not understand the Section 112 rejection applied to claims 23 - 50 regarding the word "oriented." This word does not appear in Claims 23 to 33 so the rejection of these claims seems improper. It does appear in Claims 34 to 41 and Claims 42 to 44 dependent on Claim 37. The word is properly used in accordance with the definition given in Webster's Third New International Dictionary (copy attached).

b)   Regarding the examiner's concerns with respect to "closed loop of magnetic flux:"

(1) As regards circumferential or circular magnetisation, as is disclosed in the Garshelis patents and SAE Paper 950536, a magnetoelastic ring or the like is permanently magnetised in a continuous closed annulus which inherently has an internal closed loop of magnetic flux resulting from the magnetisation.

(2) Turning to the application of the invention, an annulus of longitudinal or axially-directed magnetisation is disclosed and discussed in the present application with references to Fig. 10a. The magnetised annulus 154 will have its internal magnetic flux (due to its permanent or remanent magnetisation) directed from the South to the North pole as in a conventional magnet. A return path North to South is established through the magnetic material interior of the annulus, thereby establishing a closed loop of magnetic flux – see the present specification (based upon WO00/57150) at page 19, lines 12-22 where the closed loop is the toroid of flux. Fig. 10b shows an enhancement using inner and outer magnetised annuli of opposite polarity as disclosed at page 19, lines 24-29.

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It is emphasised that the field which is actually detected for torque or force measurement is the field that emerges externally of the transducer region – page 19, lines 22 and 23.

c) Applicant has amended the claims to delete reference to "as the case may be". Applicant has also changed ""provides" to "emanates" in claims 23, 28, 29, 30 and 39. Claim 30 has been amended to be independent and include the preamble of claim 23, and to clarify "value of applied" which was earlier recited in the claim. These changes to the claims are not meant to limit the scope of the claims under the doctrine of equivalents but are made to clarify the scope of the claim to the person of ordinary skill in the art.

d) Regarding claims 45-50, these claims have been cancelled without prejudice to reinstate the same at a later time, i.e., without disclaimer, and new method Claims 51-59 are submitted herewith. These new claims are discussed below.

8.   Claim Rejections 35 USC 103:

a) Claim 23 requires an annulus of magnetisation which may be circumferential or longitudinal (axially-directed). It is not disputed that Garshelis (in various patents, see p. 2, ll. 25 - 27) discloses circumferential magnetisation and that this form of magnetisation is accompanied by a closed loop of magnetic flux.   Garshelis does not disclose an annulus of longitudinal magnetisation.   However, the argument for patentability will first discuss circumferential magnetisation. It is respectfully submitted that the Examiner's analysis of the prior art is somewhat misdirected.   The present arguments will be directed to torque measurement. Garshelis does not seem to have appreciated the force measurement possibility. The Examiner is incorrect on page 6 of the Office Action when he states at lines 5 to 7 that Garshelis teaches:

"a torque-dependent magnetic field component which has a significant non-zero value at zero torque and an essentially zero value at a non-zero torque".

This finding is contradicted by the Examiner's conclusion at page 11, lines 5 and 6 of the Office Action that Garshelis does not teach these features. The Examiner's conclusion on page 11 is correct.

The features just-quoted are what Garshelis fails to teach and are contrary to what Garshelis does disclose. The present invention sets out to solve a deficiency in the Garshelis transducer, namely that a measurement at near zero torque is difficult because the torque-dependent magnetic field component also becomes near zero and subject to interference and noise. This is true of all the Garshelis patents relating to torque sensing based on circumferential magnetisation. It is a basic characteristic of this form of magnetisation that, absent the insight of the present invention, the magnetic field due to the circular magnetisation is entirely contained in the magnetic material at zero torque. This is exemplified by Fig. 6 of the Garshelis '605 and '423 patents where at zero torque there is zero torque-dependent detectable field. The torque-dependent field is the external detectable component. These figures are in conformity with the explanation given in the present case, formerly WO00/57150, at page 4, lines 4 to 21, particularly lines 8 to 14. The torque-dependent field is only emanated when torque is applied – page 4, lines 14 to 19. The Garshelis patents are discussed at page 2, lines 24 to 30 as Garshelis '605 and '423 patents.

The Examiner relies on the Takada and Opie et al. as supplying the teaching lacking in Garshelis – namely a significant non-zero value at zero torque and a zero value at a non-zero torque.

Firstly, Applicant considers it improper to combine Takada with Garshelis because Takada is an A.C. coupled system to which very different considerations apply as compared with the present

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invention which can be regarded as a "D.C." system, in that the transducer element comprises a remanent or permanent magnetised region which emanates a unipolar magnetic field.

Secondly, the system disclosed by Takada does not exhibit in A.C. terms and features which are analogous to those of the present invention. The Examiner relies particularly on Takada's Claim 25. He does not cite any passage in the description. Claim 25 is part of Takada's general concern which is to obtain a zero value output at zero torque despite system errors that may arise. As will be explained, the A.C. system does not have an underlying characteristic equivalent to the D.C. system.

Thirdly, Opie et al., although directed to a D.C. type of magnetic transducer system, fails to disclose features comparable to those of the present invention.   In this regard the Examiner's reliance on Col. 14, lines 1-65 is somewhat obscure.

Takada relies on a transformer-type of A.C. coupling between an exciting coil and a detector coil.   The coupling "core" is a specially treated region of a shaft, the torque of which is to be measured.   In Fig. 1, region 12 is associated with an exciting coil 16 and a detecting coil 20.   The surface of region 12 is treated to have a direction of magnetic isotropy which exhibits a magnetic property that is torque-sensitive and affects the coupling through region 12 of coils 16 and 20.   A second region 13 is provided to couple an exciting coil 17 to a detector coil 21. The two regions 12 and 13 respond to the same torque but their responses vary with opposite polarities as a function of torque.

It is to be emphasized that regions 12 and 13 of Takada are not endowed with any remanent or permanent magnetisation. Absent excitation by the relevant coil, regions 12 and 13 emanate no magnetic field.

This is in contrast with the magnetised region(s) claimed in the present invention, which is applied and which emanates, or at least have the capability of emanating under torque, a detectable external field. Claim 23 of the present invention states: "the magnetisation established in the at least one annulus emanating said magnetic field component to have a significant non-zero value at zero torque or force and an essentially zero value at a non-zero torque or force."

It is also an inherent quality of Takada's A.C. system that region 12 or 13 provides an A.C. coupling between its respective pair of excitation and detector coils.   There is necessarily a non-zero value of output at zero torque due to the transformer action through the "core" region. Furthermore, that output value will depend directly on the value of the excitation input. Thus as seen in Fig. 3 of Takada, there is a torque-dependent value of output values V_1, V_2, where V_1 and V_2 relate to regions 12 and 13 respectively.   Takada is directed to taking the difference between V_1 and V_2 to obtain a torque output curve such as shown in Fig. 4 which exhibits a zero value at zero torque. It will be noted that Takada requires two transducer regions providing responses of opposite slope to achieve this end.

Presently submitted Claim 23 requires the annulus of magnetisation to emanate a magnetic field that has an essentially zero value at a non-zero value of torque. This cannot be achieved in the A.C. coupled system of Takada. This characteristic is realised in the magnetisation of the annulus in the present invention while a predetermined torque is applied to the region in which the annulus of magnetisation is created. Assuming the magnetisation is circumferential magnetisation, then the magnetisation is in an entirely self-contained internal loop when the region is at the predetermined torque and no magnetic field is emanated.

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Such a situation simply does not apply to the A.C. system of Takada in which no remanent or permanent magnetisation is created.

Attention is drawn to Fig. 3 of Takada by way of example. It is to be noted that the curves of V_1 and V_2 relating to the regions 12 and 13 are segments of lines: neither continues to a zero value of V_1 or V_2. There is good reason for this. The regions 12 and 13 only operate over a restricted range of torque in which the material is not stressed beyond its elastic limit. It is not possible to extrapolate these line segments to a value of applied torque which would cause the measurement voltage V_1 or V_2 to reach zero. The material would already have deformed under the torque stress.

The operation of an A.C. coupled system such as that of Takada involves a mechanism of response that is entirely different from that underlying the present invention.

The Examiner relies on Claim 25 of Takada which must be read in conjunction with Claim 17 on which it is dependent. It is improper for the Examiner to extract a significant technical teaching from a claim when he can cite the alleged technical teaching from the description and drawings. In any event, Claim 25 of Takada does not support the Examiner's position.

Claim 25 of Takada is concerned with the system response of Fig. 3 from which the desired response of Fig. 4 is derived by subtracting the V_2 curve from the V_1 curve to desirably obtain a resultant response in which the output voltage is zero at zero torque. To this end the output voltages V_1 and V_2 from detecting coils 20 and 21 are made equal at zero torque. This is the operating feature to which Claim 25 of Takada is directed.

The aim of the subject matter of Claim 25 and of Fig. 4 of Takada is entirely opposite to the characteristic defined by present Claim 23 in the captioned case. Takada aims for a zero output at

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zero torque.   This is the response characteristic found also in the circumferentially magnetised transducer regions of Garshelis.   Takada therefore is teaching in the contrary direction to the invention of claimed in Claim 23 which defines a significant non-zero value of emanated magnetic field at zero torque. Takada entirely fails to teach a zero value of emanated magnetic field at a non-zero value of torque.   As explained above, it is not possible to realise such a characteristic in the A.C. coupled system of Takada.

It is respectfully submitted that Takada's aim is to achieve the desired response of Fig. 4 by correcting errors in the electronics generating the voltages V_1 and V_2 and the effect of temperature changes affecting the regions 12 and 13.

The Examiner also relies on Opie at al., citing Col. 14, lines 1 to 65. The Examiner's reliance of Opie's claim language is erroneous.

Opie et al.'s system is more fully disclosed at Col. 5, lines 35 to 46. The transducer element is magnetoelastic and is circumferentially magnetised. There are two adjacent regions 72 and 74 having opposite directions of circumferential magnetisation – see Fig. 4. Col. 5, lines 39-41 state the "magnetoelastic element 20 .... has no (our emphasis) magnetic polarity in the axial direction in the absence of torque". That is, there is zero emanated magnetic field at zero torque.   This is exactly the same situation as applies in the conventional transducer element as described by Garshelis and possesses the same problem as described in the present specification (formerly WO00/57150) at page 5, line 28 to page 6, line 14.

Opie et al. does not teach a sensor region emanating a significant non-zero value at zero torque and a zero value at a non-zero torque. The Examiner's conclusion regarding Garshelis, as expressed at page 11, lines 4-6 of the Office Action, applies equally to Opie et al.

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Claim 23 of the present invention is clearly patentable over the prior art cited by the Examiner. The prior art does not address the problem solved by the present invention. The prior art does not teach the solution of the presently claimed invention. It is respectfully requested that the Examiner withdraw the rejections to claims 23-44 and allow those claims.

Turning to the method claims 51 - 59, the novel characteristics of the transducer element defined in apparatus Claim 23 are established by what the specification refers to as pre-torque page 6, lines 16 to 22. The magnetisation of the transducer element or region is performed while it is under torque. This establishes the normal quiescent state of the element or region at a predetermined value of torque rather than at the conventional zero-torque value. A consequence is that once the torque is relaxed to zero, then a significant non-zero value of emanated field is generated. A zero value of emanated field is obtained whenever the applied torque being measured is at the predetermined (pre-torque) value.

This concept underlies new Claim 51. Claims 52 and 53 define the remanent magnetisation to be circumferential and axial (longitudinal) respectively. Circumferential magnetisation is a permanent (remanent) magnetisation of a ring or region. As regards longitudinal magnetisation in an annulus, its remanent nature is mentioned at page 19, line 17 of the present case. Claim 54 relates to applying the pre-torque concept to two annular regions which may be axially spaced as in Claim 55, e.g. Fig. 6; or which may be concentric and of opposite axial polarity as covered by Claim 58 so as to reinforce one another in generating a closed loop of flux. This is the embodiment of Fig. 10b.

Whereas the concentric or nested annular regions of Fig. 10b together provide a single transducer element, the provision of two axially-spaced transducer elements (each of which could be in accord with Fig. 10b) enables different response characteristics to be achieved, as summarised

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in the table on page 11. These responses may be combined to provide various resultant responses as, for example, is shown in Figs. 6a-6d.

In Claim 54, Applicant seeks to cover cases where the first and second torque are of the same value (and polarity) and thus may well be applied simultaneously. This applies particularly to two axially spaced regions where the two could be magnetised simultaneously while under a common torque. No new matter is introduced into the application by new method claims 51 - 59.

Allowance of claims 51-59 is respectfully requested.

Respectfully submitted,

By_____
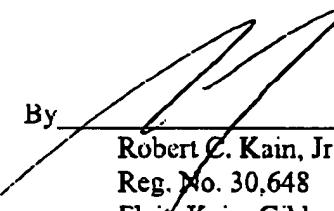
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